2016

Vol. 9. Parts 1 & 2.

The Rubber Research Scheme (Ceylon)

IMPERIAL MYCOLOGICAL INSTITUTE
10 SEPT. 1932

Combined First & Second Quarterly Circulars for 1932.

June, 1932.

H. W. CAVE & CO., PRINTERS.

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PROVED HEVEA CLONES

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FOREWORD

RUBBER growing interests in Ceylon are devoting increasing attention to the subject of budgrafting, but very few planters have the opportunity of keeping in touch with the latest information regarding proved clones. Until proved Ceylon clones become available the best planting material must be derived from other countries, and the yields and other data regarding such material are only published in foreign periodicals. The object of these notes is to present to the Ceylon planter the main facts regarding the imported clones growing in his nursery or clearing. The clones selected are those which, in the writer's experience, have been most commonly established on Ceylon estates. All the best of the older clones are included, but of those mentioned some must now be relegated to the second class. Under each heading is given a list of the clones which can be specially recommended.

There is a number of very promising newer clones being tested in Malaya, Java, and Sumatra, some of which are being used for new plantings in these countries. As far as the writer is aware these clones have not yet been introduced to Ceylon, so the data regarding them is not given in this article. Information regarding any particular clone not mentioned can be obtained on request.

It must be borne in mind that all yields and most of the other information refer to the countries in which the clones have been tested and, inasmuch as none of this material has yet been tapped commercially in Ceylon the data, as concerning the potentialities of the clones in this country, must be regarded as indicative rather than absolute. In the present state of our knowledge it is difficult to recommend a particular clone as being specially suitable for any one locality. Certain general principles, however, can be followed. In a dry district, for example, a vigorous grower with good bark renewal should receive preference, while clones susceptible to Brown Bast should be avoided. Under

* Notes regarding certain of the clones have been revised in accordance with recent information since Mr. Murray's departure on furlough.—T. E. H. O'Brien.

dry conditions, also, it would probably be preferable to select a clone with only a slight reaction in yield to wintering. Again, in replanting old rubber areas clones should be selected which have been found to grow vigorously even on poor soils.

The yields are in all cases expressed in lb. of dry rubber per annum, the number of tapping days in each year being given wherever this figure is available. It is to be noted that the number of tapping days is in nearly all cases greater than the average for Ceylon. The average yield per tapping is also given in table 5, for all the clones according to age.

The following is a list of the clones mentioned:

Prang Besar 23, 24, 25, 86, 123, 183, 186
Sungei Reko 9
A.V.R.O.S. 49, 50, 71, 80, 152, 163, 256
Bodjong Datar 2, 5, 10
Tjirandji 1, 8, 16
Cultuurtuin 88
Djasingha 1

PRANG BESAR CLONES

GENERAL NOTES

These clones are established and tested under careful supervision on Prang Besar Estate, Malaya. Yields and other information regarding the best clones are issued annually in pamphlets, from which the following notes are extracted.

All the clones mentioned below (with the exception of P.B. 86) have been tapped continuously since May, 1927, and the records for each clone have been kept from the 1st February, 1928. Tapping throughout has been on the single half cut alternate daily system without any resting, bark consumption being 10 to 11 inches per year. Renewed bark of $3\frac{1}{2}$ years has been tapped, and second renewal of all the undermentioned clones is stated to be satisfactory.

It is claimed that Prang Besar clones are tapped under strictly commercial conditions. The clones are not planted in groups, but are widely scattered over several hundred acres so that varied environmental conditions are encountered. The yield figures given below are obtained from 10 trees of each clone chosen at random over as large an area as possible. Tests have shown that the average yield from the 10 trees in test tapping is substantially the same as that from the total number of trees in the clone. The stand of trees per acre is approximately 100. The yields include scrap. Sungei Reko clone 9 is for convenience included among the Prang Besar clones, though the trees test-tapped are on Kajang Estate.

The clones to be chiefly recommended are P.B. 23, 86, 123, 183, 186, and S.R. 9.

NOTES ON INDIVIDUAL CLONES

Clone P.B. 23.—As regards growth, bark, resistance to wind, etc., this clone is very satisfactory, and does not appear to be susceptible to Brown Bast under the normal tapping system. The trees winter irregularly so that the drop in yield at the wintering period is not so pronounced as usual.

The latex has a somewhat low rubber content and there is a tendency to late dripping.

Clone P.B. 24.—As regards growth, bark, and resistance to wind, this clone is very good, but it is susceptible to Brown Bast and to external injuries. It is an early maturing clone.

Clone P.B. 25.—Growth and bark renewal is very good, but the trees appear to be liable to wind damage. Susceptibility to Brown Bast and severe and somewhat prolonged wintering are the chief defects of this clone.

Clone P.B. 86.—This clone has no serious defects. Tapping experience is more limited than for the other clones, but its excellent promise is considered to justify its selection.

Clone P.B. 123.—Growth is poor, the trees possessing little or no crown. Primary bark is good, renewal very good, and wound recovery fair. There have been a few cases of Brown Bast, but none of wind damage.

The chief merits of this clone are:

(1) It finishes yielding about 2½ hours after tapping.
(2) It has a high rubber content (about 40%), and the percentage of lower grades is small.
(3) It is early maturing.

Clone P.B. 183.—Growth is vigorous and the trees, though large, have a small crown. Bark renewal and wound recovery are good, and no trees have been in any way damaged by wind. A few buddings have developed Brown Bast, and there is a tendency to fluted growth in about 5% of the trees.

Clone P.B. 186.—This clone is by far the highest yielder amongst the Prang Besar clones for 1930 and 1931. Growth is good even on poor soils, and bark renewal is satisfactory. Its chief defect is poor wound recovery. Observations on the oldest trees of this clone have revealed no tendency towards Brown Bast. It has been found in Ceylon that budwood of this clone arrives after long transport in much better condition than the average material.

Clone S.R. 9.—Growth is vigorous, and bark and wound recovery good. The clone is stated to be resistant to disease; a few cases of Brown Bast, amounting to rather over 1%, have occurred.

TABLE I

Prang Besar Clones — *Test-Tapping Records*

Tapping Period			1927	February 1928 to January 1929		February 1929 to January 1930		February 1930 to January 1931		January to December 1931		When budded
Clone	No. of trees under observation	Acreage over which distributed	1927	Yield per tree per annum	No. of tappings	Yield per tree per annnm	No. of tappings	Yield per tree per annum	*No. of tappings	Yield per tree per annum	No. of tappings	
				Lb. oz.		Lb. oz.		Lb. oz.		Lb. oz.		
P.B. 23	44	76	Tapped. Yields not recorded	12 15	150	14 15	151	17 9	167	21 3	158	
P.B. 25	128	106		12 —	149	13 10	151	15 15	165	19 3	155	April 1922
P.B.186	265	130		11 9	151	15 2	153	22 7	168	27 9	160	
P.B. 24	94	157		10 1	149	15 1	153	18 4	168	18 2	164	Dec. 1922
P.B.123	173	89		11 11	149	15 3	152	16 12	167	16 14	156	
P.B.183	120	50		8 12	—	12 12	151	16 2	167	19 14	156	June 1923
P.B. 86	250	155			—	11 15	151	16 —	168	18 11	162	October 1923
				tapped but not recorded								
†S.R. 9	84	—		10 10	—	16 8	160	17 3	160	—	—	Oct.-Nov. 1921

* These figures refer to the period January-December 1930.
† Tested at Kajang Estate.

A. V. R. O. S. CLONES

GENERAL NOTES

The buddings of the A.V.R.O.S. clones are planted on various estates and experimental gardens in Sumatra, the test-tapping being under the general supervision of the A.V.R.O.S. Proefstation. Some of the clones are represented in more than one plantation, and the yields given in table II are for the oldest buddings of which a representative number of trees exists. The yield records show that any one clone may give a higher yield in one locality than in another, and an evaluation of two clones planted in different areas by a comparison of their yield records alone is not, therefore, strictly valid. In this respect the figures given in table II may be somewhat misleading, but a full consideration of all the records available is hardly within the scope of an article of this nature. In this connection it must be borne in mind that a definite figure cannot be given as the potential yield of any particular clone; the yield of budded trees varies according to environmental conditions in the same way as seedlings.

Tapping has been carried out daily in alternate months. Clone **256** is tapped on a single spiral cut over $\frac{1}{2}$ circumference, while the remaining clones have been tapped on a single cut over $\frac{1}{3}$ circumference since **1928**, previous to which they were tapped on $\frac{1}{2}$ spiral. The average bark consumption is **10-11** inches a year. No yield records subsequent to **1929** are available for publication, but with the exception of clone **163** satisfactory figures for **1930** have been seen.

The best clones are Nos. **49**, **50**, **152**, and **256**. There is also a number of promising newer clones with less extensive records.

Notes on the clones have been compiled from published reports supplemented by information kindly provided by the Director of the A.V.R.O.S. Proefstation.

A.V.R.O.S. 49.—The buddings lack the straight stem of some other clones but growth is vigorous and bark renewal good. The trees appear to be resistant to conditions of drought and the yield does not fall markedly during the wintering period. A report issued in **1930** indicated distinct susceptibility to Brown Bast among the trees of this clone on one estate but according to more recent information liability to disease has not been observed. It is presumed that the earlier report was based on false diagnosis. The latex has a tendency to lump formation.

A.V.R.O.S. 50.—The growth, habit, and bark renewal of this clone are very good. Several of the trees have been tapped

on renewed bark without detriment to the yield. No case of Brown Bast has been recorded. Reduction of yield during wintering is normal.

A.V.R.O.S. 71.—Growth is slow and the trees have a crooked stem with a tendency to early branching and wart formation. Bark is not very satisfactory and renewal is slow. The latex is somewhat yellow. The yield of the clone is good but there is a marked reduction in yield during wintering.

A.V.R.O.S. 80.—The growth of this clone is exceptionally good and the stem straight. Bark renewal is also satisfactory. The trees are susceptible to Pink disease and a few cases of Brown Bast have been reported. At one stage the yields of this clone were not increasing according to expectations but recent figures show an improvement.

A.V.R.O.S. 152.—Growth varies according to the type of soil and appears to be indifferent on poor soils. Bark renewal is satisfactory. It is a high-yielding clone and the reaction to wintering is negligible.

A.V.R.O.S. 163.—The buddings of this clone are liable to damage by wind, the stems being split from the base of the crown downwards. This injury has sometimes been followed by Brown Bast.

A.V.R.O.S. 256.—This is one of the highest yielders of the A.V.R.O.S. clones, but it is to be noted that the tapping is over $\frac{1}{2}$ circumference as opposed to $\frac{1}{3}$ circumference for the other buddings. Growth of the trees is vigorous, but is said to be less satisfactory on some soils; bark is thick and renewal satisfactory. The trees do not appear to be susceptible to Brown Bast. There is no marked reaction to wintering.

TABLE II

A. V. R. O. S. Clones *Test-Tapping Records*

Year		†1927		1928		1929		When budded
Clone	No. of trees	Yield per tree per annum	No. of tappings	Yield per tree per annum	No. of tappings	Yield per tree per annum	No. of tappings	
		lb. oz.		lb. oz.		lb. oz.		
49	106-112	8 6	149	10 14	162	11 11	152	1920
50	6	11 12	163	11 12	158	15 10	165	1919
71	100	* 4 8	160	7 10	159	11 4	164	October, 1922
80	50	* 4 4	160	5 5	159	7 12	164	
152	100	* 6 —	160	8 4	159	12 —	164	
163	50	* 4 8	160	7 5	159	8 7	164	
256	8-20	No records		†14 12	161	†17 1	168	1920

* These figures are calculated from the yield per tapping, the number of tapping days being taken as 160.

† Tapping over ½ circumference. Remaining figures refer to ½ circumference.

BODJONG DATAR CLONES

GENERAL NOTES

In 1922 tapping was commenced on an area of mixed budgrafts on Bodjong Datar Estate, Java. With the co-operation of the Proefstation voor Rubber the identification of the various clones present was undertaken, and test-tapping of the now well-known B.D. clones was started in 1926.

The yield records of the three best-known clones are shown in table III. With the exception of B.D. 2 which was tapped on $\frac{1}{4}$ circumference in 1930, the yields are derived from a single cut on $\frac{1}{3}$ circumference tapped on alternate days, the bark consumption being 11-12 inches a year. It will be noted that the average yields per tapping of these clones, which are now in their 14th year, are more or less stationary.

Clones B.D. 5 and 10 are amongst the best proved clones, but B.D. 2 is no longer recommended.

NOTES ON INDIVIDUAL CLONES

B.D. 2.—This is the least vigorous of the B.D. clones. The bark renewal is inferior to that of B.D. 5 and 10 and pronounced fluting of the tapping panel has been noted. Several cases of Brown Bast have been reported, and this clone is no longer recommended for planting.

B.D. 5.—This has been found a very vigorous grower in other countries though the buddings often take a long time to shoot. Primary bark is exceptionally thick and renewal is excellent. There are no records of wind damage and Brown Bast does not appear to be common.

It has been found in Ceylon that B.D. 5 is extremely susceptible to *Phytophthora* attack on green shoots, and in many nurseries the plants of this clone are backward on this account. The probable susceptibility of the mature trees to *Phytophthora* "secondary" leaf-fall may prove a serious objection to the planting of this clone in the wet districts in Ceylon.

B.D. 10.—Slightly less vigorous than B.D. 5, primary bark and renewal also being not quite so good. There is a slight tendency to form corrugations on the tapping panel, but these do not interfere with tapping of renewed bark. Wound recovery is not good. There is a slight tendency to Brown Bast. No losses have been reported from wind damage.

TABLE III

Bodjong Datar Clones Test-Tapping Records

Year		June 1926 to May 1927		1928		1929		1930 (11 months)		1931	
No. of tapppings		170		162		171		158		173	
Age		9		10½		11½		12½		13½ yrs.	
Clone	No. of trees	Yield per tree per annum		Yield per tree per annum		Yield per tree per annum		Yield per tree per annum		Yield per tree per annum	
		lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.
B.D 2	10-17	15	6	17	6	18	—	*12	8	*13	3
B.D.5	6-8	18	8	25	5	25	15	26	10	29	15
B.D.10	44-50	16	11	18	14	20	—	17	13	21	12

* Tapped over ¼ circumference. Remaining figures refer to ⅓ circumference.

TJIRANDJI CLONES

GENERAL NOTES

The Tjirandji clones are planted on Tjirandji Estate, Java, and are test-tapped under the general supervision of the Proefstation voor Rubber. Tapping is alternate daily on a single cut over $\frac{1}{3}$ circumference, with the exception of Tjirandji I which has been test-tapped on $\frac{1}{4}$ circumference since October, 1928. Bark consumption is stated to be 3 cm per month, or about 14 inches a year.

Tjir I and XVI have been planted on a very extensive scale, but Tjir VIII is only recommended for mixed planting. The yields of these three clones since 1928 are given in table IV.

NOTES ON INDIVIDUAL CLONES

Tjirandji I.—Only two of the original five trees are remaining, the other three having unfortunately been destroyed by a cyclone in January, 1929. They are consequently very widely spaced, and the published yield figures may be higher than would be expected under normal commercial conditions. The yield is markedly depressed during wintering. The clone is a very vigorous grower and bark renewal is satisfactory. The period of flow of the latex extends to the early afternoon. In 1928 one of the five trees was reported to have developed Brown Bast, but there has been no recurrence of this disease. It is now stated by the Proefstation at Buitenzorg that "the occurrence of Brown Bast has never been ascertained". There is no reason to suppose that the clone is specially liable to wind damage; the storm which destroyed three of the trees also blew down most of the trees in its path.

Information has recently been received from a reliable source that younger buddings of Tjir I, which are being test-tapped at an age of 4-5 years, are yielding well, but no figures are at present available.

Tjirandji VIII.—The trees show vigorous growth and there has been, in Ceylon, a tendency to favour the clone on this account. The yields are lower than those of Tjir I and XVI and it is only recommended in Java for planting in mixed areas.

Tjirandji XVI.—Growth is stated to be slightly less vigorous than Tjir I, and in Ceylon it has been found to be a slow grower. Primary bark is thick and renewal very good. The fall in yield during wintering is less than for Tjir I. No Brown Bast or windbreaks have been reported.

TABLE IV

Tjirandji Clones *Test-Tapping Records*

Year		1928		1929		1930		1931	
Age		8½		9½		10½		11½ yrs.	
Clone.	No. of trees	Yield per tree per annum	No. of tappings	Yield per tree per annum	No. of tappings	Yield per tree per annnm	No. of tappings	Yield per tree per annum	No. of tappings
		lb. oz.		lb. oz.		lb. oz.		lb. oz.	
Tjir I	2-5	30 9		*26 10		*35 3	178	*41 6	179
Tjir VIII	34-35	15 13		16 5		17 10	178	18 1	179
Tjir XVI	11	24 —	181	23 13	174	20 3	180	21 6	—

* Tapping over ¼ circumference. Remaining figures refer to ⅓ circumference.

MISCELLANEOUS CLONES

CULTUURTUIN 88

The buddings of this clone were planted in the Cultuurtuin, Buitenzorg in 1918 and it is therefore one of the oldest clones. The yields have not increased in accordance with expectations and it is now only regarded as being of historical interest. The trees are subject to wind damage owing to the peculiar type of branching.

DJASINGHA 1

Buddings were planted out in 1920 on the Peuteuj division of Djasingha Estate and were separated into clones in 1928 by the Proefstation voor Rubber. The only yield figures available locally are those shown in table 5, on the basis of which the clone cannot be considered very promising.

TABLE V

Clone	Tapping system	No. of trees	Yield in grams of dry rubber per tapping at the ages of (from date of establishment to middle tapping year).																	
			4	4½	5	5½	6	6½	7	7½	8	8½	9	9½	10	10½	11	11½	12	12½	13½
P. B. 23	½ a. d.	10						39·3		44·7		54·0		60.9							
P. B. 24	½ a. d.	10				32.8		44·8		49·2		50.3									
P. B. 25	½ a. d.	10						36.0		40.9		42.9		56.2							
P. B. 86	½ a. d.	10					35·7		42.3		52.4										
P. B.123	½ a. d.	10			32.3		45·3		45·5		49.2										
P. B.183	½ a. d.	10					38·3		43·5		57.8										
P. B.186	½ a. d.	10						34.8		45.0		58.4		78.3							
S. R. 9	½ a. d.	84						30.3		46.2		(49)									
AVROS 49	⅓ d.a.m.	106–112	*6.2		*14.5		*21.3		*25.6		30.7		34.9								
AVROS 50	⅓ d.a.m.	6	*8.2		*18.7		*37·5		*40.6		31.6		33.4		43.3						
AVROS 71	⅓ d.a.m.	100	*7.8	*12.8		21.8		31.2													
AVROS 80	⅓ d.a.m.	50	*6.3	*12.1		15.2		21.6													
AVROS 152	⅓ d.a.m.	100	*9.7	*17.1		23.6		33.2													
AVROS 163	⅓ d.a.m.	50	*7.8	*12.7		20.8		23.3													
AVROS 256	½ d.a.m.	8–20									43.4		46.1								
B. D. 2	⅓ a. d.	10–16											41.2			48.8		47.9		†36.2	†34.9
B. D. 5	⅓ a. d.	7–8											49.4			71·0		69.0		76.8	78.7
B. D. 10	⅓ a. d.	48–50											44.7			53.1		53.2		51.5	55.4
Tji I	⅓ a. d.	2–5										(79)		†(69)		†89.8		†105.0			
Tji VIII	⅓ a. d.	34–35										(41)		(42)		44.7		45·9			
Tji XVI	⅓ a. d.	11										60.2		62.1		51.3		53.9			
Djasingha I	½ t. d.	42–151						(16)		(30)		36.4				‡37.8					
Ct 88	½ d.a.m.	25				18·5					(15)		(26)		(36)						

Figures in brackets have been calculated from available data, and are only approximate. * Tapping on ½ d.a.m. † Tapping on ⅓ a.d. ‡ Tapping on ½ a.d.

Yields in this table are shown as grams per tapping in order to facilitate comparison with the performance of young Ceylon clones.

A POPULAR ACCOUNT OF RECENT WORK OF THE RUBBER RESEARCH STAFF IN LONDON ON THE PRODUCTION OF UNIFORM RUBBER IN CEYLON.

G. MARTIN, B.Sc., A.I.C., F.I.R.I.,
(OF THE SCIENTIFIC STAFF IN LONDON OF THE CEYLON RUBBER RESEARCH SCHEME)

A series of three reports have been issued recently dealing with the preparation of uniform rubber (Bulletin No. 52) and the present article is intended as a popular résumé of the work described in these reports, which are necessarily difficult to follow by anyone not familiar with testing operations as carried out in London.

For convenience the account is divided into three parts dealing with (1) the meaning of uniformity, (2) the reason for seeking uniformity, (3) the progress made.

(1) "MEANING OF UNIFORMITY

A planter is compelled by market standards to think of uniformity in terms of colour, markings, dimensions, texture etc. Unfortunately different samples of rubber which appear to be uniform according to these superficial standards may vary widely in their behaviour in manufacturing operations and in the quality of the manufactured product which they yield. The work in London therefore deals with uniformity in terms of chemical and physical properties related to manufacturing behaviour. These properties can only be determined by technical tests which have been correlated as far as possible with manufacturing procedure and requirements.

(2) "THE REASON FOR SEEKING UNIFORMITY"

The principal aim of the work in London is to improve the quality of first-grade rubber from Ceylon with a view to increasing the advantages of this type of plantation rubber over alternative materials (lower grades of rubber, reclaim, plastics etc.) and to render it more suitable for use in industries where other materials are now employed.

The principal reason for the use of first-grade plantation rubber in place of lower grades is its greater reliability and any steps which can be taken to increase its superiority in this connection must obviously place it in a better position to meet the competition from amber blanket crepe, etc.

As regards the competition of materials entirely different from rubber, the experience of the Rubber Growers' Association has shown that it is very difficult to find new applications for rubber in the engineering and building industries owing to the greater uniformity of the products at present employed.

A reputation for uniformity is an excellent selling point and probably could be more easily obtained in Ceylon than where the units engaged in rubber production are of a more extensive and varied character.

In the present article an account is given of the steps being taken to produce uniform rubber.

(3) "PROGRESS MADE"

Before attempting to obtain uniformity it is necessary to know the type of rubber which is required. This is a difficult point because rubber is used for many different purposes. Without going into technical details it may be stated that for most purposes the rubber industry requires a soft easily manipulated rubber which vulcanises comparatively slowly when mixed with sulphur, which responds to accelerators and has good properties after vulcanisation with regard to strength, resistance to abrasion, resistance to fatigue, resistance to ageing, etc.

To determine whether it is possible to prepare this type of rubber throughout Ceylon a series of investigations is in progress. It is necessary to know whether successive consignments of rubber from latex from one group of trees are uniform and the investigations described in the first report (Preparation of Uniform Rubber, Part 1) deal with this point. The results show that with the present standard of supervision in estate factories fairly uniform rubber can be obtained from successive crops of latex from one group of trees for a period of more than twelve months and therefore presumably for a very long period. It is not suggested that the product is as uniform as many of the other materials used by engineers but the variability is too small to cause marked difficulty in rubber-manufacturing operations.

De Vries has mentioned in his book "Estate Rubber" (Batavia, 1920) that some estates in Java produce remarkably uniform rubber. By the kindness of the Proefstation voor Rubber at Buitenzorg a series of samples was supplied at monthly intervals from a carefully controlled estate in Java to the staff in London and they have been examined both in London and Java. The results given by these samples are dealt with in the second report (Preparation of Uniform Rubber, Part 2). Both research organisations agree that the rubber is

reasonably uniform as regards rate of vulcanisation in a rubber-sulphur mixing. The uniformity obtained was of the same order as that from carefully controlled estates in Ceylon. There is, therefore, every reason to expect that uniform rubber can be prepared in Ceylon and Java and differences in conditions and method of preparation are not likely to favour the production of uniformity in one country to the disadvantage of the other.

The third report deals with the extent of variability in hardness of Ceylon rubber (Preparation of Uniform Rubber, Part 3). Other properties are under examination. For this investigation samples have been obtained from most estates in Ceylon.

From a comparison of the variability in hardness throughout Ceylon and on one estate, it is concluded that there is considerable scope for improving the uniformity of rubber in respect of hardness.

These three reports show therefore that (1) successive consignments of rubber from latices from one group of trees are fairly uniform, (2) rubber is variable in hardness when obtained haphazardly from a number of estates.

When the examination is completed of the extent of variability of Ceylon rubber in respect of properties other than hardness, it is proposed that the Research Scheme officers should study the preparation of rubber on estates supplying an abnormal product, and it is hoped that it will be possible to suggest methods by which rubber from these estates may be prepared with properties conforming to the requirements of the manufacturing industry.

By this means it is hoped that crepe and sheet supplied from Ceylon will be in accord with manufacturers requirements, and that the improved uniformity will lead to a better market for first-grade rubber.

Imperial Institute,
London, S.W. 7,
26th November, 1931.

THE EFFECT OF HEVEA LATEX LIPIN ON THE MANIPULATION OF RUBBER

(BY THE SCIENTIFIC STAFF IN LONDON OF THE CEYLON RUBBER RESEARCH SCHEME)

MESSRS. Rhodes and Bishop of the Rubber Research Institute, Malaya, have isolated from Hevea latex a complex of fatty acids, sugar, and ether soluble phosphorus and nitrogen possessing the properties of a class of bodies known as lipins. They observed that the material had a peculiar effect on mastication and Dr. Rhodes supplied a small quantity with the suggestion that a study of its effect on plasticity would be of interest.

Hardness.—Some difficulty has been experienced in determining the effect of the lipin on the hardness of rubber and owing to the absence of sufficient material it has not been possible to carry out all the experiments necessary for a definite conclusion. The difficulty was occasioned by the remarkable effect of lipin in preventing the adhesion of rubber surfaces.

In preparing a test piece for the determination of hardness it is customary to grind the rubber once through the mixing rolls. The thin sheet is then rolled under tension into a cylinder from which a spherical pellet weighing 0·4 grams is cut.

In the first experiment crepe was smeared with the lipin and then passed once through the mixing rolls in the usual way, but a coherent sheet could not be obtained.

In the second experiment the crepe was first sheeted and then smeared with lipin, but owing to the absence of adhesion it could not be rolled into a suitable cylinder.

In the third experiment the cylinder of crepe was prepared and then smeared with lipin. This was kept for a week in order that the lipin, if soluble, might penetrate into the rubber. There was no evidence from the appearance of the sample that the lipin had dissolved and it is possible that in preparing the test piece all the lipin was removed. The results of hardness tests were:

	$\frac{D_{30}}{mm}$
Control	1·58
Control treated with lipin ...	1·57

There is no evidence that lipin has any effect on hardness but this is probably due to its removal in the preparation of the test piece.

A further experiment was made in which four test-pellets were prepared and smeared with lipin. Two were cut to the correct weight before treatment and the other two brought to correct weight by smearing with lipin. At the temperature employed for hardness test (100°C) the pellets coated with lipin were observed to swell and to become serrated before submitting to compression. The results of hardness tests were as follows:

	$\frac{D_{30}}{mm}$
Control	1·69
Control smeared with lipin	1·48 and 1·32
Control smeared with lipin to the required weight ...	1·21 and 1·33

These results suggest that lipin has a marked softening effect on rubber, but it is possible that the excess of lipin on the surface of the rubber causes slip to occur at the surfaces in contact with the plastimeter. That the results obtained are due to slippage is confirmed by their irregularity.

The only conclusion from these tests is that lipin is very effective in preventing the adhesion of rubber surfaces. In order to obtain more definite information concerning the effect on hardness it is suggested that lipin dispersed in water should be mixed with latex and then sheet or crepe prepared in the usual way. The additional amount of lipin (if any) retained by the rubber could be ascertained by a determination of the nitrogen and phosphorus content of the rubber in comparison with a control.

Mastication.—In the first experiment 3 per cent of the lipin was smeared on the surface of crepe prior to mastication. The rubber crumbled into a large number of small pieces on passing through the mixing rolls and could not be united to form a single sheet under the mastication conditions employed for testing purposes. It was observed previously that dry serum has a similar but not nearly such a marked effect.

A further experiment was made using only 1 per cent of lipin. Again the rubber crumbled into a large number of small pieces, but it was possible eventually to build up a coherent sheet.

The results of the mastication tests given below cannot be regarded as a complete index of the effect of lipin on mastication

as during the period while the rubber was in the form of crumb only a small portion at a time could be passed through the nip of the rolls.

	Mastication No.
Crepe control ...	78
Crepe treated with 1 per cent of lipin	180 (approx.)

It is concluded that the effect of lipin on the amount of mastication required to reduce the rubber to a fixed plasticity is mostly due to the crumbling which makes it impossible to give a sample smeared with lipin the same mechnical treatment as the control. If it were possible to disperse the lipin in the rubber before commencing mastication it would have a greatly reduced effect.

It was observed in Malaya that the crumbling effect was considerably reduced in the presence of zinc oxide. A mixing of rubber and zinc oxide in the proportion of 100:10 was therefore divided into two portions. On one portion was smeared 1 per cent of lipin which was thoroughly dispersed in the rubber on the mixing rolls. The rubber did not actually crumble although there was a tendency for crumbling to occur. The other portion of the zinc-oxide mixing received the same mechanical treatment as that treated with lipin.

The following are the results of plasticity determinations:—

	Plasticity K
Control	0·98
,, coated with 1 per cent lipin	0·87

$$K = \frac{\frac{1}{S_X^2} - \frac{1}{S_O^2}}{t}$$ (See Martin Trans. I.R.I. 1930-31, p. 298).

Mastication had less effect on the plasticity of rubber in the presence of lipin than in its absence. As the effect of the lipin is only small it is doubtful whether lipin which was thoroughly dispersed in the rubber before commencing mastication would have any effect.

Scorching.—Some consignments of rubber "scorch" very easily during manipulation and therefore cause considerable difficulty in manufacturing operations owing to premature vulcanisation. Samples which vulcanise quickly in a rubber-sulphur mixing usually "scorch" easily. It is, therefore,

presumed that "scorching" depends upon non-rubber accessory substances and that the amount of lipin present may be of importance.

A crepe rubber-sulphur mixing (100:10) was prepared and divided into two portions. Into one portion was mixed 1 part of lipin per 100 parts of rubber. The other was given the same mechanical treatment without any addition. Both mixings were kept at 100°C and their plasticity determined after different periods of heating.

A similar experiment was carried out with a zinc-oxide mixing consisting of 100 rubber, 10 zinc-oxide and 10 sulphur. The results of plasticity determinations are shown below and also in Fig. 2.

	Plasticity (K)			
	Rubber-sulphur mixing		Zinc-oxide mixing	
Period at 100°C (hrs.)	Control	Control + lipin	Control	Control + lipin
1	1·03	0·81	1·71	1·43
3	0·86	0·69		
4	0·59	0·53	0·46	0·27
5	0·52	0·39	0·22	0·05
6			0·086	0·027

These results show that lipin has little effect on the "scorching" of a rubber-sulphur mixing but has a tendency to encourage scorching in a zinc-oxide mixing.

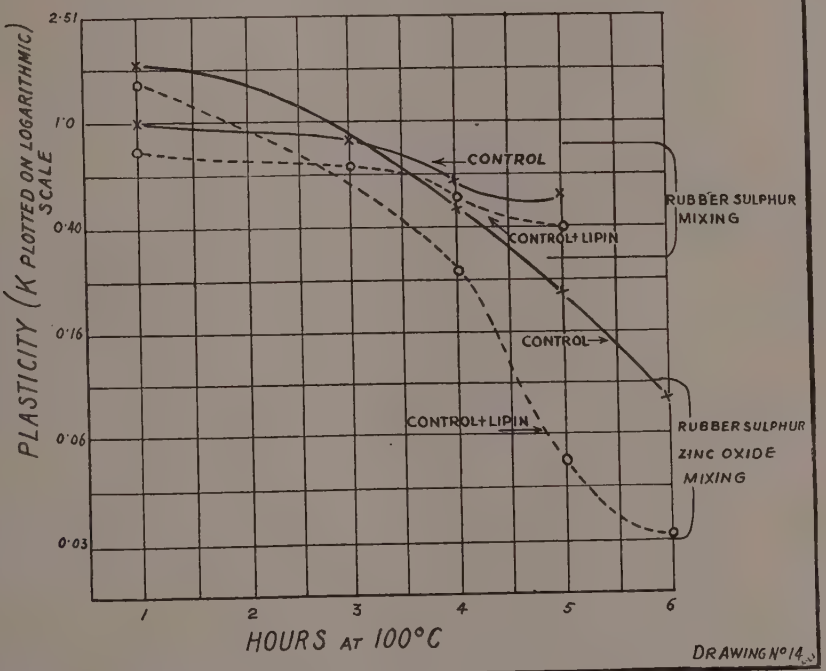
This is the first occasion on which this scorching test has been employed and it would be necessary to acquire further experience before definite conclusions can be drawn as to the importance of the effect observed in the zinc-oxide mixing. If it is assumed that the amount of lipin in rubber is usually small and that the variations in the amount present are much less than in this experiment when 1 per cent of lipin was deliberately added to the rubber, it seems likely that lipin is not the cause of the tendency of some rubbers to "scorch" easily.

Recovery.—The extent to which rubber recovers from mechanical deformation is of considerable importance in its manipulation.

A preliminary experiment was, therefore, carried out to determine whether lipin had any effect on "recovery". For this purpose the "recovery" of a lipin-treated pellet after compression during hardness tests was compared with that of a control pellet. No difference was observed. This result indicates that lipin has no effect on the elasticity of raw rubber.

FIG 2

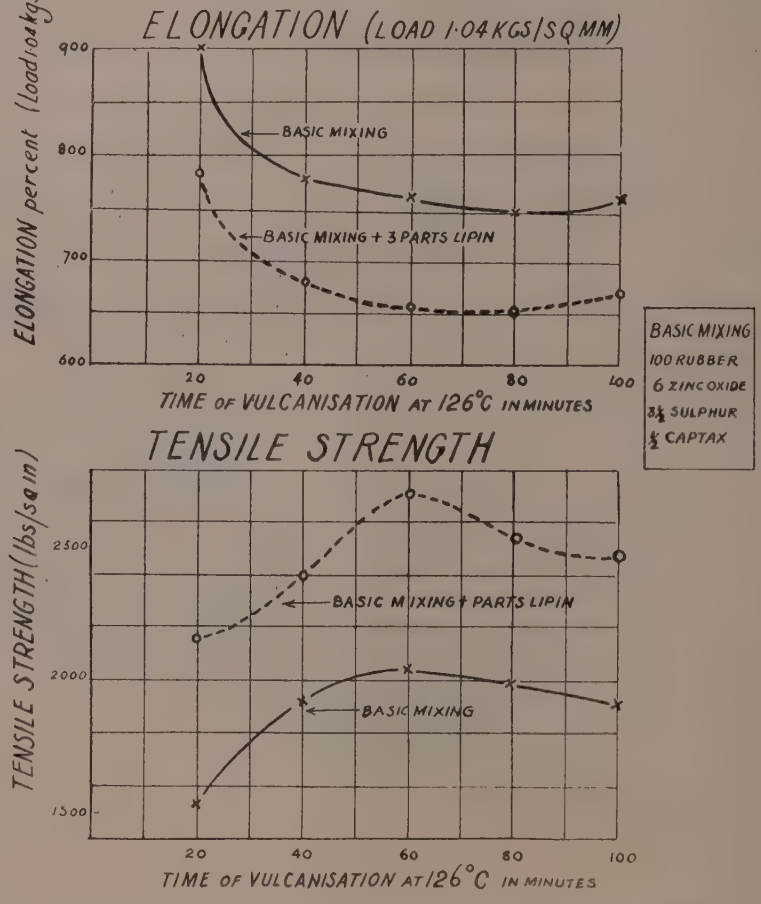
EFFECT OF LIPIN ON "SCORCHING"



DRAWING N°14

FIG 3

VULCANISATION TEST IN CAPTAX MIXING



DRAWING No 15

VULCANISATION

(a) *Rubber-Sulphur Mixing.*—It was found in Malaya that lipin acted as an accelerator of the vulcanisation of a rubber-sulphur mixing when added to quick-curing rubber, such as slab or alcohol-coagulated crepe, but had only a mild effect when added to ordinary crepe or sheet. There was only sufficient of the material in London to carry out a test on one sample of rubber, and it was found that 3 parts of lipin in the 90:10 rubber-sulphur mixing reduced the time of vulcanisation of smoked sheet by nearly 30 per cent. This is comparable with the effect observed in Malaya on fast-curing rubber. There is, therefore, a discrepancy between the results of the vulcanisation tests in Malaya and in London. It is possible that the effect of lipin varies considerably with different samples of crepe and sheet.

(b) *Accelerator Mixing.*—As lipin contains 70 per cent of fatty acids (mostly in combination) it is possible that it will have an effect on the vulcanisation of some accelerator mixings. A very popular accelerator at present is mercaptobenzothiazole, which confers valuable physical properties on vulcanised rubber. The behaviour of this accelerator is modified by fatty acids. The effect of 3 parts of lipin per 100 of rubber on the vulcanising properties of the following mixings was accordingly determined: 100 rubber, 6 zinc-oxide, $3\frac{1}{2}$ sulphur, $\frac{1}{2}$ captax (mercaptobenzothiazole). This mixing is based on one employed by Dinsmore and is understood to be typical of American compounding practice with regard to the proportions of the compounding ingredients. The results obtained are as follows:—

Time of vulcanisation at 126°C.	Control		Control + 3 parts lipin	
	Tensile Strength	Elongation at load of 1·04 kgs/sq. mm.	Tensile Strength	Elongation at load of 1·04 kgs. sq. mm.
(mins.)	(lbs./sq. in.)	(per cent)	(lbs./sq. in.)	(per cent)
20	1,530	896	2,160	780
40	1,920	774	2,390	677
60	2,060	761	2,660	655
80	2,000	742	2,540	650
100	1,910	754	2,450	665

The lipin has no effect on the time required for the vulcanisation of this mixing, but it leads to a considerable improvement in the physical properties of the vulcanised material, as shown by the greatly increased tensile strength and the lower elongation at a given load (see Fig. 3). From the point of view of

abrasion, the mixing containing the added lipin would probably be distinctly superior to the mixing without.

That the same improvement in the physical properties of the control cannot be obtained by adding stearic acid is shown by the following results of tests using the same mixing but other samples of raw rubber.

CONTROL (SAMPLE A)

Time of vulcanisation at 126°C.	Control		Control + 1 part stearic acid	
	Tensile Strength	Elongation at load of 1·04 kgs./sq. mm.	Tensile Strength	Elongation at load of 1·04 kgs./sq. mm.
(mins.)	lbs./sq. in.)	(per cent)	(lbs./sq. in.)	(per cent)
20	930	—	750	—
40	1,860	874	1,890	836
60	1,940	820	1,850	773
80	1,960	803	1,880	748
100	1,900	797	1,970	735

CONTROL (SAMPLE B)

Time of vulcanisation at 126°C.	Tensile Strength	Elongation at load of 1·04 kgs./sq. mm.	Control + 2 parts stearic acid: Tensile Strength	Control + 2 parts stearic acid: Elongation at load of 1·04 kgs/sq. mm.
(mins.)	(lbs./sq. in.)	(per cent)	(lbs./sq.) in.)	(per cent)
20	1,670	873	1,300	—
40	1,900	753	2,270	722
60	2,240	728	2,280	670
80	2,400	714	2,420	644
100	2,240	713	2,460	632

These results show that stearic acid reduces the extent to which the vulcanised material stretches at a given load but unlike lipin does not have a marked effect on tensile strength. It is possible that lipin is a better dispersing agent than stearic acid. This would account for the improved tensile strength.

It is difficult to indicate at present how the fact that lipin has a marked effect on the tensile strength of captax mixings can be used to the advantage of the rubber-growing industry, but it is suggested that the investigations in Malaya on the preparation of lipin and its presence in crepe and sheet are of considerable importance from the point of view and preparing rubber of the highest quality, and may eventually lead to the production of improved material.

AGEING

(a) *Raw Rubber.*—A sample of crepe was smeared with lipin and kept at 70°C in comparison with a control to determine whether the lipin had an effect on the changes in the plasticity of the rubber due to oxidation.

The following results were obtained:—

	D_{∞} after keeping at 70°C for days.			
	1	*7*	*12*	*19*
Control ...	1·69	1·58	1·60	1·34
Control + lipin ...	1·56	1·52	1·54	1·23

It is concluded from these results that lipin has little effect on the rate of oxidation of raw rubber.

(b) *Vulcanised Rubber.*—The effect of 3 parts of lipin on the ageing properties of vulcanised smoked sheet (90:10:3) is shown in the following table:

Sample	Time of vulcanisation (mins.)	Tensile strength after ageing at 70°C for hours (lbs./sq. in.)				Elongation at load of 1·04 kgs./sq. mm. after ageing at 70°C for hours (per cent)			
		nil	*48*	*96*	*144*	*nil*	*48*	*96*	*144*
Control (90:10)	85	2,010	2,120	630	210	859	747	699	—
Control + lipin (90:10:3)	61	1,900	2,020	1,860	330	858	753	706	—

The lipin has enabled the rubber to retain its tensile strength for a longer period than the control. The magnitude of the effect is much less than that produced by proprietary anti-oxidants. This improvement is possibly due to the reduced time of vulcanisation.

REMARKS

From the results of these tests the conclusion is drawn that the lipin naturally present in crepe and sheet has little effect on the plastic and elastic properties of raw rubber, but that raw rubber surfaces treated with lipin lose their capacity to adhere. This effect is not so marked in the presence of compounding ingredients.

Lipin acts as an accelerator of vulcanisation in a rubber-sulphur mixing without compounding ingredients, but the potency of the lipin depends upon factors which are not yet understood.

A preliminary experiment showed that lipin has a beneficial effect on a "Captax" mixing. The effect is so marked that if lipin were available in large quantities at a reasonable price it would have good commercial prospects as a compounding ingredient.

Lipin has a slight tendency to increase the rate of scorching of a zinc-oxide mixing, but not that of a rubber-sulphur mixing.

It has no tendency to retard the oxidation of raw rubber but has a slight beneficial effect on the ageing of a vulcanised rubber-sulphur mixing.

Owing to the absence of sufficient material the possible use of lipin outside the rubber industry has not been studied experimentally. Preliminary enquiries indicate however that there are prospects of a large market in the food manufacturing industry. The lipin found in latex is similar in composition and properties to "lecithin". Commercial lecithin contains about 60 per cent pure lecithin and commands a price of about 5s. per lb.

It is stated that it can be employed to give margarine the consistency of butter, but enquiries indicate that there is at present no demand for lecithin for this purpose. A considerable amount of work is proceeding with a view to using lecithin in the chocolate industry and it is for this purpose that proprietary brands of lecithin prepared from soya beans are now on the market. It improves the manipulation of fats in the chocolate industry, prevents blooming of chocolate and sedimentation of cocoa when used as a beverage.

There is no commercial prospect for lipin as a by-product of the rubber industry, unless it can be obtained from waste serum.

Imperial Institute,
London, S.W. 7.
Nov. 26, 1931.

THE EFFECT OF CONDITIONS OF STORAGE ON THE HARDNESS OF RUBBER

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IN order to convert raw rubber into manufactured articles it is generally necessary to render the rubber plastic by a kneading process which involves passing it repeatedly through heavy rollers. The rubber becomes more and more plastic according to the amount of rolling it receives, after which it can be mixed with compounding ingredients and then by suitable machinery brought to the desired shape and vulcanised. Some samples of rubber do not require as much kneading as others. In the case of first-grade estate rubber from Ceylon it is found that some samples require half the kneading of others.

This variation causes considerable difficulty in processing and encourages the mixture with first-grade rubber of considerable quantities of materials which facilitate manipulation. For example, it is often stated that the principal virtue of reclaim is that it facilitates manufacturing operations. This advantage is of such importance that in spite of the low price of raw rubber American manufacturers still find it convenient to use on an average 1 lb. of reclaim for 3 lb. of raw rubber, including the lower grades. There is no doubt that if first-grade plantation rubber could be more easily manipulated it would command a stronger position relative to lower grades and reclaim.

A considerable amount of work has been carried out in London with a view to the preparation in the East of rubber which is more plastic than ordinary crepe or sheet, and one of the relative problems studied has been the cause of the variation in plasticity.

Particulars have already been published of an experiment from which conclusions were drawn as to the cause of variability in plasticity (*First Quarterly Circular*, 1931, *p.* 7). This experiment showed that rubber kept in dry oxygen was much softer

at the end of six months than the same rubber kept in nitrogen and that the difference was more marked the higher the temperature. As the variation in the plasticity of samples of rubber generally develops on keeping, it is concluded that the differences in the plasticity of first-grade rubber are principally due to differences in the rate of oxidation. The non-rubber accessory substances contain important compounds which retard oxidation and the rate of oxidation of rubber is dependent upon the amount or nature of these substances present.

Another experiment has now been carried out with a sample of crepe and sheet kept in air and nitrogen for six months, not only under different temperature conditions but also under different humidity conditions. The different humidity conditions were obtained by exposing the samples in sealed glass tubes over dry calcium chloride and saturated solutions of sodium chloride, potassium chloride, and potassium sulphate. At 15°C sodium chloride gives a relative humidity of 75·2 per cent, potassium chloride 84·8 per cent, and potassium sulphate 97·3 per cent. The relative humidity of these saturated salt solutions is not greatly affected by temperature.

The results of hardness tests D_{30} on crepe and sheet stored under these conditions are shown in Table I and Fig. 1.

TABLE I.

Form of rubber	Sample No.	Hardness before storage	Relative humidity during storage	Hardness after storage for six months in air at 15°C	in air at 30°C	in air at 45°C	in air at 70°C	in nitrogen at 15°C	in nitrogen at 30°C	in nitrogen at 45°C	in nitrogen at 70°C
		mm.	per cent	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.
Blanket crepe	1568	1·76	dry	1·91	1·97	2·00	1·40	1·85	2·11	2·16	1·76
			75·2	1·71	1·67	1·56	1·08†	1·76	1·74	1·70	1·45†
			84·8	1·68	1·61	1·61	1·16†	1·70	1·72	1·73	1·28†
			97·3	1·74	1·67	1·52	0·45†	1 74	1·75	1·70	1·48†
Smoked sheet	1569	1·65	dry	1·77	1·83	1·67	1·54†	1·99	1·94	1·96	1·96
			75·2	1·75	1·76	1·54	1·12†	1·79	1·83	1·65	1·60†
			84·8	1·77	1·67	1·58	1·16†	1·76	1·74	1·62	1·26†
			97·3	1·62	1·66	1·34	0·51†	1·66	1·71	1·59	1·45†

† Two months' storage only.

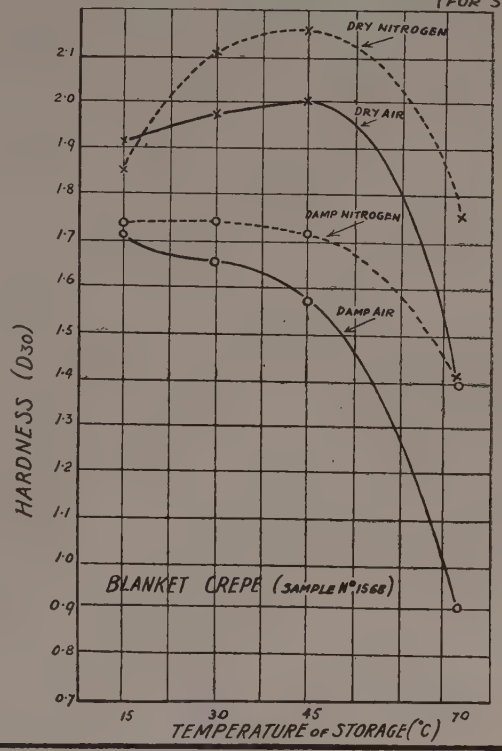
REMARKS

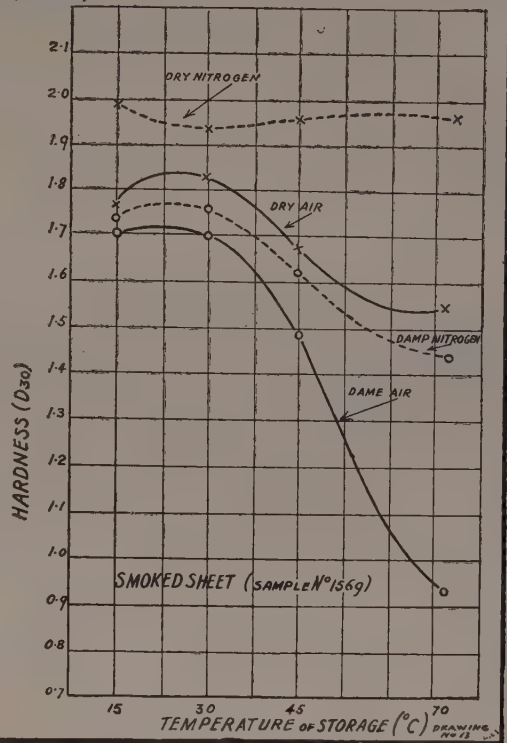
(1) Previous experiments have shown that crepe and sheet are much softer after storage in dry air than after storage in dry nitrogen in the absence of oxygen. The present experiments confirm this conclusion and show that it also holds for damp air and damp nitrogen.

FIG I

THE EFFECT ON HARDNESS OF STORAGE UNDER DIFFERENT CONDITIONS

(FOR SIX MONTHS)





(2) The difference between the hardness of rubber stored in air or in nitrogen of the same humidity increases with temperature and may become very marked after keeping for two months at 70°C.

(3) The difference between the hardness of rubber stored in air or nitrogen is not definitely affected by the presence of moisture, except at 70°C. At this temperature the results are somewhat irregular but there is no doubt that wet rubbers become much softer than drier rubber.

(4) Rubber is softer when stored in damp air or nitrogen than when stored in a very dry atmosphere.

(5) There is no evidence that the usual variation in the amount of moisture in the atmosphere causes differences in the hardness of rubber on keeping.

(6) Even in damp air at 30°C or lower rubber may become a little harder on keeping. There is no evidence as to the cause of this change.

From these experiments it is concluded that the following external factors tend to have a marked and permanent effect on the hardness of rubber. (1) Oxygen. (2) The complete absence of moisture and (3) Temperature.

It is presumed that the extent of alteration in hardness is controlled by the following internal factors, viz: (1) Oxidation catalysts, negative and positive, (2) Some factor which controls the tendency of rubber to harden when kept at 30°C or lower.

Of the above external and internal factors responsible for variation in hardness of different samples of raw rubber only two are obviously of practical importance, viz. (1) the temperature of storage and (2) the presence of positive and negative oxidation catalysts. The former accounts for the difference in the hardness of rubber stored in London and in the Tropics and the latter for much of the variation which is experienced by manufacturers.

The results of these experiments indicate that hard rubber can be obtained by (a) treating latex, coagulum or dry rubber with anti-oxidants, (b) storage of rubber at 30-45°C in the complete absence of moisture.

It is desirable that experiments should be carried out in the tropics on the preparation of hard rubber with a view to exploring in this country the market possibilities of what appears to be a novel product.

The preparation of soft rubber (which is one of the principal objects of this investigation) can obviously be accomplished by oxidation, but it is doubtful whether there would be a good market for material which was known to be oxidised. It is desirable, however, that the properties of oxidised rubber should be determined as it is probable that there is a quantity of soft rubber already on the market which owes its softness to oxidation, although the oxidation is not deliberate.

Moreover the opinion is held in some quarters that the plasticising of rubber by manufacturers is essentially an oxidation process in which case carefully controlled oxidation of the rubber in the East would have distinct advantages. Experiments along these lines are in progress.

Imperial Institute,
London, S.W. 7,
10th December, 1931.

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